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Magn. Reson. Discuss., referee comment RC1
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Comment on mr-2022-4

Anonymous Referee #1

Referee comment on "A portable NMR platform with arbitrary phase control and temperature compensation" by Qing Yang et al., Magn. Reson. Discuss., https://doi.org/10.5194/mr-2022-4-RC1, 2022

The manuscript describes the digital and analog electronics of a portable NMR spectrometer. It consists of a non-commercially available CMOS integrated circuit designed by the authors (TX/RX electronics with RF PA, RF LNA, mixers, IF amplifier, PLL) and of commercially available electronics (DDS chips, multifunction analog/digital board, switches, …). The operation of the spectrometer is demonstrated with 1H NMR experiments at 62 MHz and 15 MHz using home-made NMR probes consisting of 0.4 and 2 mm diameter solenoidal coils tuned (but not impedance matched) with capacitors. Liquid samples are placed in 0.3 and 1.3 mm outer diameter glass capillary, which tightly fit inside the solenoidal coils.

The most original contribution of this work is the detailed description of a TX/RX phase synchronization method and of a field drift correction method. Of course, the TX/RX phase synchronization and the field drift are problems which are "solved" in all commercially available NMR spectrometers. However, the merit of this manuscript lies in the fact that the method chosen and the hardware required to solve these problems are described in detail and, hence, can be useful to other groups which are working at the development of compact/portable NMR spectrometers. For this reason, I think that the manuscript deserve to be published.

Suggestions for the improvement of the manuscript:

LINE 23: Typo: "high field homogeneity" instead of "high filed homogeneity"

LINE 35: Typo: "Anders and Boero, 2008" instead of "Anders and Chiaramonte, 2008" (Chiaramonte is not author of that conference paper). Correct also LINE 350.

LINE 47: At this point in the manuscript, it is not entirely clear the meaning of "phase-coherent detection of the NMR signal at non-zero IF". A non-zero IF can be produced also with F_LO=F_TX but different from F_LARMOR. In this case there are no phase-coherence issues. Later in the manuscript (LINE 75) it is clear that "non-zero IF" means F_LO different from F_TX, which indeed can produce phase-coherence issues. It is not essential, but maybe I would try to make this clear already at this point of the manuscript.

LINE 71 (footnote): "Ignoring the inhomogeneity factor". I guess the authors refer to the B1 inhomogeneity which would than produce a non-homogeneous flip angle in the sample (and, in particular, a flip angle which is not 90° everywhere in the sample). It is almost obvious but I would be more clear.

LINE 97: In the given reference (Anders et al., 2010) the impact of gain and phase mismatch on the NMR spectra distortions is not discussed/shown in details. I would suggest to search for references where this issue is discussed/shown more in details.

LINE 107: I would write "NdFeB permanent magnet" instead of "Neodymium permanent magnet". I would also add the value of its typical temperature coefficient (about 0.1%/K at room temperature).

LINE 132: If the scaling factor is selectable from 0.5 to 64, is it correct that the output frequency is between 5.7 MHz and 770 MHz?

LINE 138: I would specifically mention the gain of the LNA and the gain of the mixer (even if it is already mentioned the total RX gain and the gain of the VGA and the gain of the external filter).

LINE 142: I would mention which specific 130 nm BiCMOS technology has been used for the integrated circuit.

LINE 165: Figure 3b: I would add a scale bar (even if the dimensions are given in the caption).

LINE 182: Typo (I guess): "…within a few microseconds" instead of "….with a few microseconds"

LINE 230: Figure 5: I would add a scale bar (even if the coil dimensions are given in the text).

LINE 232: It would be nice to show a picture of the custom made 0.36 T magnet and give some details of it.

LINE 233: I would specify on which volume you have an homogeneity of 20 ppm (I guess it is on the sample volume).

LINE 257: I would specify the repetition time (i.e., the time distance between two consecutive measurements). At first sight, I would have performed many more consecutive measurements than 100. Do you expect any significant difference if 1000, 10000, or more measurements are taken? Which is the origin of the observed standard deviation of the phase? Is it just due to noise present in the signal which set a limit in the standard deviation of the phase or it is larger and due to a residual phase syncronization problem (it is probably possible to run a simple simulation to clarify this point)?

LINE 261: Table 1: It is not clear to me why it is relevant to show also the mean value of the phase. I would specify the number of measurements (10, I guess from the text) and the repetition time. As for the previous case, I would have performed many more consecutive measurements than 10. Do you expect any significant difference if 100, 1000, 10000, or more measurements are taken?

LINE 287: Although it might be well known for most of the NMR specialists, I would explain in some more details why "…the predefined pulse length is no longer correct, resulting in distorted CPMG signals".

LINE 295: Figure 9. I would specify the sample used for this measurement. Is it again sunflower oil? T2 is slightly shorter (77 ms) than the one in Figure 8 for sunflower oil (85 ms). As addition to Figure 9a, I would suggest also to add the CPMG "decay" obtained with the temperature induced field drift compensation scheme.

LINE 296: It is not clear to me if and why the measurements with heterogeneous samples are relevant to qualify the phase-synchronization and field-correction approach proposed in this paper. Of course, these are additional nice measurements that can be included in the article but their "relevance" for the main messages of the paper is not fully clear to me.

LINE 308: Table II: I wonder if it make sense (and it is correct in metrology terms) to specify the T2 and T1 values with so many significant digits (I guess not but I'm not sure).

LINE 310: Figure 10: I would mention the Cu concentration in the figure caption or directly in the figure (even if these number are given in the text).

LINE 325: I would add a few citations to the articles corresponding to "….our EPR-on-a-chip transceivers".

"Aesthetic" comment: for my personal taste, there is an excessive use of footnotes. I would move all current footnotes (or the large majority of them) in the main text.